Original Article

Comparative effect of 12 weeks of slow and fast pranayama training on pulmonary function in young, healthy volunteers: A randomized controlled trial

Dinesh T, Gaur GS[1], Sharma VK[1], Madanmohan T[3], Harichandra Kumar KT[2], Bhavanani AB[4]

Department of Physiology, Vinayaka Mission's Medical College and Hospital, Karaikal, Departments of [1]Physiology and [2]Medical Biometrics and Informatics, Jawaharlal Institute of Postgraduate Medical Education and Research, [3]Department of Physiology, [4]Centre for Yoga Therapy Education and Research, Mahatma Gandhi Medical College and Research Institute, Puducherry, India.

Address for correspondence: Dr. Girwar Singh Gaur,
Department of Physiology,
Jawaharlal Institute of Postgraduate Medical Education and Research,
Puducherry - 605 006, India.
E-mail: drgsgaur@yahoo.com

ABSTRACT

Context: Pranayamas are breathing techniques that exert profound physiological effects on pulmonary, cardiovascular, and mental functions. Previous studies demonstrate that different types of pranayamas produce divergent effects.

Aim: The aim was to compare the effect of 12 weeks of slow and fast pranayama training on pulmonary function in young, healthy volunteers.

Settings and Design: This study was carried out in Departments of Physiology and ACYTER, Jawaharlal Institute of Postgraduate Medical Education and Research, Puducherry in 2011.

Subjects and Methods: Ninety one healthy volunteers were randomized into slow pranayama group (SPG), *n* =29, fast pranayama group (FPG), *n* = 32 and control groups (CG) (*n* = 30). Supervised pranayama training (SPG: *Nadisodhana*, *Pranav* pranayama and *Savitri* pranayama; FPG: *Kapalabhati*, *Bhastrika* and *Kukkriya* pranayama) was given for 30 min/day, thrice/week for 12 weeks by certified yoga instructors. Pulmonary function parameters (PFT) such as forced vital capacity (FVC), forced expiratory volume in first second (FEV_1), ratio between FEV_1 and FVC (FEV_1/FVC), peak expiratory flow rate (PEFR), maximum voluntary ventilation (MVV), and forced expiratory flow$_{25-75}$ (FEF_{25-75}), were recorded at baseline and after 12 weeks of pranayama training using the computerized spirometer (Micro laboratory V1.32, England).

Results: In SPG, PEFR, and FEF_{25-75} improved significantly ($P < 0.05$) while other parameters (FVC, FEV_1, FEV_1/FVC, and MVV) showed only marginal improvements. In FPG, FEV_1/FVC, PEFR, and FEF_{25-75} parameters improved significantly ($P < 0.05$), while FVC, FEV_1, and MVV did not show significant ($P > 0.05$) change. No significant change was observed in CG.

Conclusion: Twelve weeks of pranayama training in young subjects showed improvement in the commonly measured PFT. This indicates that pranayama training improved pulmonary function and that this was more pronounced in the FPG.

Key words: Fast pranayama; healthy lungs; pulmonary function test; slow pranayama.

INTRODUCTION

In the recent decades, awareness and interest have increased in yogic techniques that include pranayamas. They are gaining more importance and becoming acceptable to the public as well as scientific community.[1]

Access this article online	
	Quick Response Code
Website: www.ijoy.org.in	
DOI: 10.4103/0973-6131.146051	

As a deep breathing technique, pranayama reduces dead space ventilation and decreases work of breathing. It also refreshes the air throughout the lungs, in contrast with shallow breathing that refreshes the air only at the base of the lungs.[2] Regular practice of pranayama improves cardiovascular and respiratory functions, improves autonomic tone toward the parasympathetic system, decreases the effect of stress and strain on the body and improves physical and mental health.[3-5]

Pulmonary function parameters (PFT) provide important clinical information to identify and quantify the defects and abnormalities in the functioning of the respiratory system.[6] Spirometry is the basic and useful method available for evaluating these PFT.[7] To the best of our knowledge, there has been no study, which compared the effect of slow and fast pranayama training on PFT. In view of the above background, this study was planned to study the effect of 12 weeks of slow and fast pranayama training on PFT in young healthy volunteers.

SUBJECTS AND METHODS

This study was conducted at Puducherry in 2011. The subjects were recruited from the students of various courses conducted in Jawaharlal Institute of Postgraduate Medical Education and Research (JIPMER), Puducherry as well as staff, friends, and relatives of them after obtaining approval from JIPMER Scientific Advisory Committee and Ethics Committee (Human Studies). Subjects after meeting the inclusion and exclusion criteria mentioned below were explained the benefits of yoga training and motivated to enroll for the study.

Inclusion criteria

- Healthy volunteers of both genders in the age group of 18-30 years.

Exclusion criteria

- History of chronic respiratory illness
- Subjects on medication
- Smokers and alcoholics
- Athletes
- Any history of previous yoga or bio feedback techniques training in last 1-year.

The purpose of this study, procedures and benefits were briefed to them. The willing participants were randomized into slow pranayama group (SPG) ($n = 29$), fast pranayama group (FPG) ($n = 32$), and control group (CG) ($n = 30$), after getting informed written consent, by simple randomization method using random numbers generated through computer. Average age of the volunteers was 18.58 ± 2.27 (mean ± standard deviation). Among these 91 volunteers, 72 were females and the remaining 19 were males.

The subjects were advised to come at least 2 h after light breakfast and with light clothing. They were instructed to avoid drinking beverages and performing a vigorous exercise 30 min before the recording of parameters. PFT such as forced vital capacity (FVC), forced expiratory volume in first second (FEV_1), ratio between FEV_1 and FVC (FEV_1/FVC), peak expiratory flow rate (PEFR), maximum voluntary ventilation (MVV), and forced expiratory flow$_{25-75}$ (FEF_{25-75}) were recorded at baseline and after 12 weeks of pranayama training by using the computerized spirometer (Micro laboratory, V1.32, England).Supervised pranayama training (SPG: *Nadisodhana*, *Pranav* pranayama and *Savitri* pranayama; FPG*: Kapalabhati, Bhastrika* and *Kukkriya* pranayama) was given for 30 min/day, thrice/week for the duration of 12 weeks to SPG and FPG by the certified yoga trainer as per the guidelines of Morarji Desai National Institute of Yoga, New Delhi (Appendix). Rest of the days, subjects were motivated to practice at their home. CG did not practice any pranayama during the study period. The techniques of fast and slow type of pranayamas were as described in the previous literatures.[8,9]

RESULTS

The comparison of PFT between baseline and post test is given in Table 1 and Figures 1 and 2. The normality of the continuous data was tested by using Kolmogorov–Smirnov test. After 12 weeks of slow pranayama training PEFR and FEF_{25-75} were significantly improved ($P = 0.02$ and $P < 0.01$, respectively) when compared with the values at baseline. However, other parameters (FVC, FEV_1, FEV_1/FVC, and MVV) had shown only a marginal improvement ($P > 0.05$).

After 12 weeks of fast pranayama training FEV_1/FVC, PEFR, and FEF_{25-75} were significantly improved ($P = 0.02$, $P < 0.001$, and $P < 0.001$, respectively) compared

Table 1: Comparison of pulmonary function parameters between baseline and post test among the study groups (mean±SD)

Parameters	SPG (n=29)	FPG (n=32)	CG (n=30)
FVC (L)			
Pre	2.45±0.66	2.36±0.66	2.12±0.48
Post	2.51±0.69	2.28±0.55	2.13±0.48
FEV_1 (L)			
Pre	2.39±0.63	2.32±0.61	2.07±0.44
Post	2.44±0.70	2.272±0.55	2.11±0.45
FEV_1/FVC (%)			
Pre	97.8±3.42	98.4±3.38	98.32±4.64
Post	97.51±3.05	99.84±0.47*	98.82±2.15
PEFR (L/m)			
Pre	296.76±96.32	288.88±108.3	264.57±84.23
Post	322.31±104.36*	336.31±89.21***	274.9±76.03
MVV (L/m)			
Pre	89.61±23.79	87.04±22.86	79.29±16.37
Post	91.46±26.34	84.39±21.30	75.62±13.77
FEF_{25-75} (L/s)			
Pre	3.52±0.96	3.68±1.04	3.45±0.94
Post	3.68±0.98**	4.28±0.89***	3.56±0.84

Analysis done by Student's paired *t*-test. *P<0.05; **P<0.01; ***P<0.001. SPG = Slow pranayama group; FPG = Fast pranayama group; CG = Control group; FEV_1 = Forced expiratory volume in first second; FVC = Forced vital capacity; FEV_1/FVC = Ratio between forced expiratory volume in first second and forced vital capacity; PEFR = Peak expiratory flow rate; MVV = Maximum voluntary ventilation; FEF_{25-75} = Forced expiratory flow at 25-75%; SD = Standard deviation with the values at baseline. However, other parameters (FVC, FEV_1, and MVV) did not show significant ($P > 0.05$) change. In CG, no significant change was observed in any of the PFT after 12 weeks of the study period.

Comparison of longitudinal changes in PFT is given in Table 2 and Figure 3. The changes in PFT such as MVV and FEF_{25-75} were found to be statistically significant overall among the three groups ($P < 0.05$ and $P = 0.001$, respectively). The value of MVV was increased by 1.85 ± 5.20 on an average in SPG ($P = 0.04$). However, in FPG and CG, it was decreased by 2.65 ± 7.60 and 3.67 ± 11.92, respectively ($P > 0.05$).

Table 2 and Figure 2 demonstrate that on comparing SPG and FPG, significantly higher change was observed only in FEF_{25-75} parameter in FPG ($P = 0.001$). Therefore, our results demonstrate that FPG is more effective than SPG on the above-mentioned PFT.

DISCUSSION

Pranayama involves manipulation of breath movement, and the breath is a dynamic bridge between the body and mind. It consists of three phases: *Purak* (inhalation), *Kumbhak* (retention), and *Rechak* (exhalation) that can be practiced in either slow or fast manner.[10] Results of our study demonstrate that there was no significant difference in the baseline values of PFT. Therefore, all the three groups can be considered comparable for this study. Our results indicate that both pranayama practices had beneficial effect on PFT except respiratory pressure parameters, and the effect of fast pranayama was significantly more on FEF_{25-75}, which is in the effort dependent area of a flow-volume curve. Our results are in agreement with previous studies who have reported that yogic practices, including pranayama training produce statistically significant improvement in the commonly measured PFT.[11-14] A study by Joshi *et al*. has demonstrated that 6 weeks of exclusive pranayama training improves the ventilatory functions in the form of the increase in FVC, FEV_1, MVV, and PEFR in healthy subjects.[15] Sivakumar *et al*. studied the acute effect of deep breathing (2-10 min) and observed an improvement in the PFT parameters in healthy volunteers.[16]

Table 2: Comparison of the delta changes in pulmonary function parameters among the study groups (mean±SD)

Parameters	SPG (n=29)	FPG (n=32)	CG (n=30)
FVC (L)	0.06±0.17	−0.08±0.23	−0.02±0.36
FEV_1 (L)	0.05±0.149	−0.05±0.20	−0.03±0.32
FEV_1/FVC (%)	−0.29±3.397	−1.44±3.38	−0.51±4.71
PEFR (L/m)	25.55±56.11	47.44±63.92	10.33±75.71
MVV (L/m)	1.85±5.20	−2.65±7.60	−3.67±11.92*
FEF_{25-75} (L/s)	0.17±0.27##	0.60±0.72	0.10±0.47##

Analysis done by one-way ANOVA with Tukey post-hoc analysis. *P<0.05; **P<0.01; ***P<0.001; #P<0.05; ##P<0.01; ###P<0.001. SPG = Slow pranayama group; FPG = Fast pranayama group; CG = Control group; FEV_1 = Forced expiratory volume in first second; FVC = Forced vital capacity; FEV_1/FVC = Ratio between FEV_1 and FVC; PEFR = Peak expiratory flow rate; MVV = Maximum voluntary ventilation; FEF_{25-75} = Forced expiratory flow at 25–75%; SD = Standard deviation

Yadav and Das attributed that improvement in the PFT parameters by yogic practices due to increased respiratory

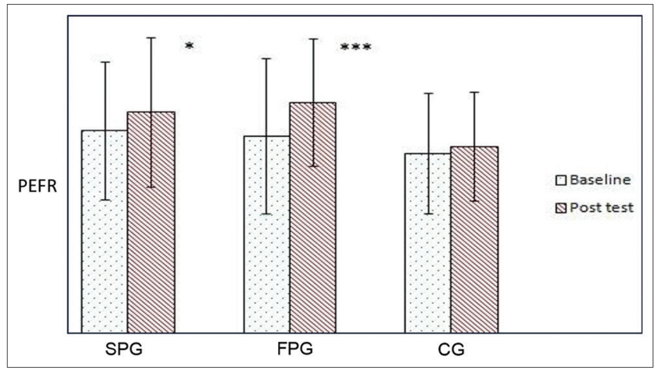

Figure 1: Comparison of peak expiratory flow rate of the study participants after 12 weeks of study period. SPG: Slow pranayama group, FPG: Fast pranayama group, CG: Control group. Analysis done by Student's paired *t*-test. *P < 0.05, **P < 0.01, ***P < 0.001

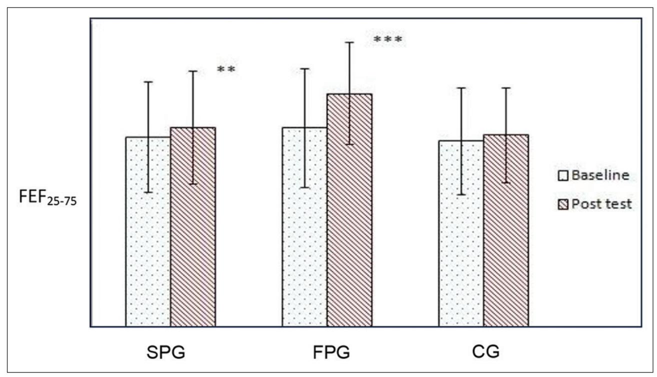

Figure 2: Comparison of forced expiratory flow at 25-75% (FEF_{25-75}) of expiratory flow volume (FEF_{25-75}) of the study participants after 12 weeks of study period. SPG: Slow pranayama group, FPG: Fast pranayama group, CG: Control group. Analysis done by Student's paired *t*-test. *P < 0.05, **P < 0.01, ***P < 0.001

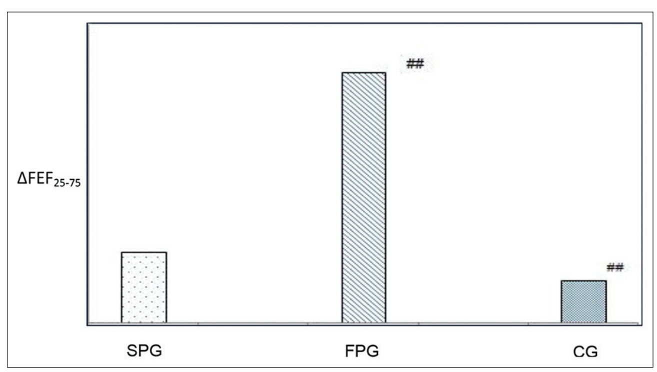

Figure 3: Comparison of Δforced expiratory $flow_{25-75}$ (difference between posttest and baseline parameters) in the three study groups after 12 weeks of the study period. SPG: Slow pranayama group, FPG: Fast pranayama group, CG: Control group. *With respect to SPG, #with respect to FPG. Analysis done by one-way ANOVA with Tukey *post-hoc* analysis. *P < 0.05, **P < 0.01, ***P < 0.001. #P < 0.05, ##P < 0.01, ###P < 0.001

muscle strength, clearing of respiratory secretions and using the diaphragmatic and abdominal muscles for filling the respiratory apparatus more efficiently and completely. Furthermore, the improvement in the PFT parameters may be due to rise in thoracic – pulmonary compliances and broncho dilatation by training in *Nadisodhana* pranayama.[17] Stimulation of pulmonary stretch receptors by inflation of the lung reflexely relaxes smooth muscles of larynx and tracheo bronchial tree. Probably, this modulates the airway caliber and reduces airway resistance.[13] Previous investigators demonstrated the effect of pranayama on enhancement of the respiratory muscle efficiency and lung compliance due to reduction in elastic and viscous resistance of lung.[18] Furthermore, pranayama acts as stimulus for release of lung surfactant and prostaglandins into alveolar spaces, which increases the lung compliances.[15]

Significantly higher improvement in PFT parameter (FEF_{25-75}) in FPG can be hypothesized to the reason that breathing during fast pranayama requires breath coordination at higher rate and hence, higher rate of respiratory muscle activity. This produces strengthening of the respiratory muscles and therefore, improvement in the effort produced by the subjects.

CONCLUSION

Our results demonstrate that both slow and fast pranayamas are beneficial on most of the tested PFT parameters, and fast pranayama was more effective than slow pranayama. These changes by both pranayama techniques can be attributed to improved autonomic tone toward parasympathodominance resulting in a relaxed state of mind, better subjective well-being and concentration on the task, improved lung ventilation and strength of respiratory muscles.[19]

REFERENCES

1. Udupa K, Madanmohan, Bhavanani AB, Vijayalakshmi P, Krishnamurthy N. Effect of pranayam training on cardiac function in normal young volunteers. Indian J Physiol Pharmacol 2003;47:27-33.
2. Bijlani RL. The yogic practices: Asanas, pranayams and kriyas. In: Bijlani RL, editor. Understanding Medical Physiology. 3rd ed. New Delhi, India: Jaypee Brothers Medical Publishers; 2004. p. 883-89.
3. Udupa KN, Singh RH. The scientific basis of yoga. JAMA 1972; 220:1365.
4. Bhargava R, Gogate MG, Mascarenhas JF. Autonomic responses to breath holding and its variations following pranayama. Indian J Physiol Pharmacol 1988;32:257-64.
5. Bal BS. Effect of anulom vilom and bhastrika pranayama on the vital capacity and maximal ventilatory volume. J Physical Educ Sport Manage 2010;1:11-15.
6. Wallace RK, Benson H, Wilson AF. A wakeful hypometabolic physiologic state. Am J Physiol 1971;221:795-79.
7. Standardization of Spirometry, 1994 Update. American Thoracic Society. Am J Respir Crit Care Med 1995;152:1107-36.
8. Crapo RO. Pulmonary-function testing. N Engl J Med 1994;331:25-30.
9. Swami GG. Pranayama: The Fourth Limb of Ashtanga Yoga. Pondicherry, India: Satya Press; 2008.
10. Sharma VK, Trakroo M, Subramaniam V, Rajajeyakumar M, Bhavanani AB, Sahai A. Effect of fast and slow pranayama on perceived stress and cardiovascular parameters in young health-care students. Int J Yoga 2013;6:104-10.
11. Chodzinski J. The effect of rhythmic breathing on blood pressure in hypertensive adults. J Undergrad Res 2000;1:78-98.
12. Birkel DA, Edgren L. Hatha yoga: Improved vital capacity of college students. Altern Ther Health Med 2000;6:55-63.
13. Mandanmohan, Jatiya L, Udupa K, Bhavanani AB. Effect of yoga training on handgrip, respiratory pressures and pulmonary function. Indian J Physiol Pharmacol 2003;47:387-92.
14. Keele CA, Erik N, Noman J. The chemical regulation of respiration. Samson Wright's Applied Physiology. 13th ed., Vol. 209. New Delhi: Oxford University Press; 2003. p. 170-1.
15. Joshi LN, Joshi VD, Gokhale LV. Effect of short term 'Pranayam' practice on breathing rate and ventilatory functions of lung. Indian J Physiol Pharmacol 1992;36:105-8.
16. Sivakumar G, Prabhu K, Baliga R, Pai MK, Manjunatha S. Acute effects of deep breathing for a short duration (2-10 minutes) on pulmonary functions in healthy young volunteers. Indian J Physiol Pharmacol 2011;55:154-59.
17. Yadav RK, Das S. Effect of yogic practice on pulmonary functions in young females. Indian J Physiol Pharmacol 2001;45:493-96.
18. Srivastava RD, Jain N, Singhal A. Influence of alternate nostril breathing on cardiorespiratory and autonomic functions in healthy young adults. Indian J Physiol Pharmacol 2005;49:475-83.
19. Jerath R, Edry JW, Barnes VA, Jerath V. Physiology of long pranayamic breathing: Neural respiratory elements may provide a mechanism that explains how slow deep breathing shifts the autonomic nervous system. Med Hypotheses 2006;67:566-71.

How to cite this article: Dinesh T, Gaur GS, Sharma VK, Madanmohan T, Harichandra Kumar KT, Bhavanani AB. Comparative effect of 12 weeks of slow and fast pranayama training on pulmonary function in young, healthy volunteers: A randomized controlled trial. Int J Yoga 2015;8:22-5.

Source of Support: JIPMER and Vinayaka Mission's Medical College, **Conflict of Interest:** None declared

APPENDIX

Methods of pranayama training given to study groups

1. Fast pranayama: Each cycle (6 min) consisted of practicing 1 min of *Kapalabhati*, *Bhastrika* and *Kukkriya* pranayama interspersed with 1 min of rest between each pranayama. Subjects were asked to complete three or more cycles in each session.
   - *Kapalabhati* pranayama: The subjects were instructed to sit in *Vajrasana* and to forcefully expel all of the air from the lungs, while pushing the abdominal diaphragm upwards. The expulsion is active, but the inhalation is passive. Subjects rapidly breathed out actively and inhaled passively through both nostrils. One hundred and twenty rounds at a sitting was the maximum. It is considered an excellent rejuvenator of the respiratory system as all muscles of expiration are exercised
   - *Bhastrika* pranayama: In this, emphasis is given to thoracic (not abdominal) breathing activity. Subjects were instructed to take deep inspiration followed by rapid expulsion of breath following one another in rapid succession. This is called as "bellow" type of breathing. Each round consisted of 10 such "bellows." After 10 expulsions, the final expulsion is followed by the deepest possible inhalation. Breath is suspended as long as it can be done with comfort. Deepest possible exhalation is done very slowly. This completes one round of *Bhastrika*
   - *Kukkriya* pranayam: To perform this dog pant like breathing technique, the subject sat in *Vajrasana* with both palms on the ground in front with wrists touching knees and fingers pointing forward. The mouth was opened wide, and the tongue pushed out as far as possible. They then breathed in and out at a rapid rate with their tongue hanging out of their mouth. After 10 or 15 rounds, they relaxed back into *Vajrasana*. The whole practice was repeated for three rounds

2. Slow pranayama: Each round (7 min) of the session consisted of practicing 2 min of *Nadishodhana*, *Pranava* and *Savitri* pranayama interspersed with 1 min of rest between each pranayama done in comfortable posture (*Sukhasana*). Subjects were asked to perform nine or more rounds according to their capacity.
   - *Nadishodhana* pranayama: This is slow, rhythmic, alternate nostril breathing. One round consisted of inhaling through one nostril, exhaling through other nostril and repeating the same procedure through other nostril
   - *Savitri* pranayama is a slow, deep and rhythmic breathing, each cycle having a ratio of 2:1:2:1 between inspiration (*Purak*), held-in breath (*Kumbhak*), expiration (*Rechak*), and held out breath (*Shunyak*) phases of the respiratory cycle. Each lobular segment of the lungs was filled and a six-count was used for inspiration and expiration, with a three-count for the retained breaths ($6 \times 3 \times 6 \times 3$)
   - *Pranava* pranayama is slow, deep and rhythmic breathing where an emphasis is placed on making the sound AAA, UUU and MMM, while breathing out for duration of 2-3 times the duration of the inhaled breath. It is a four-part technique consisting of Adham pranayama (lower chest breathing with the sound of AAA), Madhyam pranayama (mid-chest breathing with the sound of UUU), Adhyam pranayama (upper chest breathing with the sound of MMM) and then the union of the earlier three parts in a complete yogic breath known as Mahat Yoga pranayama with the sound of AAA, UUU, and MMM.

At the end of session, all Groups 1 and 2 subjects were instructed to lie down in shavasana and relax for 10 min.